

## Patient was Injured by a High Pressure Water Jet

Unlike many other injuries, those caused by a high pressure water jet (HPWJ) must be **taken very seriously** and constitute a special variety of foreign matter interspersed. The injuries are frequently more extensive than they look, as a large amount of water can enter the body through a relatively small hole within a short time and cause major damage there.

Due to the numerous types of injuries which can be caused by HPWJ, the list below is restricted to some universally valid facts.

### Possible Types of Injuries

#### Cuts

- Lacerated tissue, no large amount of damaged soft tissue, severed bone and amputated extremities or parts of extremities as a result.  
*(Possible cause: sharply focussed jet of pure water or watercontaining abrasive substances, which was moved slowly across a part of the body).*
- Incised tissue, seriously damaged tissue even at some distance from the wound due to the impact pressure produced.  
*(Possible cause: rapid movement of the jet across a part of the body).*

#### Contused (Crush) Injuries

- Injured area of the tissue around the jet entry point is enlarged.  
*(Possible cause: high effective diameter of the nozzle at low jet energy)*
- Crush injury of the skin and destruction of deeper-seated anatomical structures. Due to the extensive damage to the tissue, wound-healing is impaired. The damaged tissue should be surgically removed and then re-covered using suitable plastic surgery methods. *(Possible cause: a fanned water jet)*
- The externally visible damage is not suspicious at first glance. Bruises may appear and the area reacts increasingly painfully. Under its surface, the damaged muscle can swell and compress nerves and blood vessels (compartment syndrome). This can result in an extensive destruction of cell and muscle tissue. *(Possible cause: the jet energy was too low to penetrate the skin)*
- Damage to important organs such as the brain, heart or liver.  
*(Possible cause: the jet hit areas above important organs and transfers energy)*



### Information for the Doctor

#### On-site First Aid

1. Elevate injured part of the body.
2. Cover the wound with sterile material or bandage. Apply pressure bandage if it bleeds profusely.
3. Keep the injured person under observation.
4. Pack any severed body parts in a sterile cloth or clean plastic bag and chill if possible.
5. Transport to trauma surgery unit as quickly as possible.

## Damage Caused by Contaminated Medium

A water jet that has passed through the skin transports foreign substances such as abrasives, paint particles, oil, bacteria or other substances into the body, even if pure water was used as a medium. The injected particles can be microscopic in size. These substances spread in the tissue along muscles, nerves, tendons or blood vessels, or if the jet's course was deflected after hitting bone. The exact extent of the contamination can only be defined by extensive operative exposure.

## Other Risks

Extensive and/or very painful injuries can be life-threatening as the patient may suffer a shock.

## Working Principle of a High Pressure Water Jet System

In a high pressure water jet system, a working medium - usually water - is compressed by a pressure generator and transported through pipes or tubes to a nozzle by which the high pressure is converted into fluid jet velocity. The operating jet speeds involved are of the order of twice the speed of sound and are produced with system pressures of up to 300 MPa (3000 bar). The typical nozzle diameter for hand-operated jetting systems is 0.5 to 3 mm.

## Summary

1. The skin can be penetrated by water jets even at a relatively low pressure of approximately 40 bar.
2. The jet can be deflected internally or intercepted by harder tissue and cause internal injuries.
3. A large amount of fluid can be injected within a short time.
4. The first impression of the wound may be that it is only superficial, however, it is possible for major internal damage to occur.
5. Foreign substances such as abrasives or impurities can be injected with the water and contaminate even deeper-seated tissues.

## References:

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**Information  
for the Doctor**

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